

RTCA Special Committee 209
ATCRBS / Mode S Transponder MOPS Maintenance
Meeting #7
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Proposed Requirement for S1 P1 Detection

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SUMMARY

The TCAS whisper-shout steps assume that a traditional receiver design will not recognize the S1 pulse below MTL. DO-181, ED-73, and ICAO Annex 10 do not actually require or test the transponder to ensure this assumption is true. This paper proposes a requirement to close this hole in the specifications.

1.0 Introduction

The TCAS whisper-shout steps assume that a traditional receiver design will not recognize the S1 pulse below MTL. DO-181, ED-73, and ICAO Annex 10 do not actually require or test the transponder to ensure this assumption is true. This Working Paper proposes a requirement to close this hole in the specifications.

2.0 Background

The TCAS MOPS defines Whisper - Shout steps for the purpose of decluttering ATCRBS replies. These steps are implemented by controlling the amplitude of the S1 pulse relative to P1. The assumption of the TCAS specification is that the transponder will not be able to "see" a pulse if it is below the MTL of the receiver. If P1 is above MTL and S1 is below, theoretically the transponder should reply. However, there is no requirement in the SARPs or MOPS that forces the transponder to behave this way. As a result, newer designs, specifically the Garmin GTX-330, have been released that did not initially behave that way. These requirements apply to both Mode S and ATCRBS transponders since some TCAS I systems use ATCRBS interrogations without P4 to acquire Mode S transponders.

3.0 Need for Adding Requirements for S1 P1 Detection

The current transponder requirements documents, DO-181C, ED-73B, and ICAO Annex 10 Amendment 77, do not currently require the transponder to decode S1 P1 in the manner assumed by the TCAS MOPS. This allows vendors to design certified units that are invisible to TCAS.

3.1 Collaboration with the ICAO ASP TSG

This Working Paper was reviewed as **TSG WP03-05** by the ICAO ASP TSG during their meeting recently concluded at DGAC in Paris on 2 – 6 July 2007. After discussion, the TSG agreed that a requirement was required to ensure that whisper shout operates as intended. A review of the SARPs did not reveal a logical place to insert this requirement, since the S pulse is only defined in the ACAS guidance material. The TSG recommended that the requirements of TSG WP03-05 be added to the RTCA and Eurocae MOPS.

4.0 Honeywell Measurements

Honeywell has taken measurements of our existing Mode S equipment and have a rough idea of what is realistic behavior for fielded units over temperature. Other vendor's equipment may vary from our data, and even our data will vary from unit to

unit. However, we believe that the following requirement can be realistically met by existing equipment and satisfies the operational goals of the TCAS system.

It still needs to be verified by TCAS experts that the proposed threshold is theoretically adequate. A TSG Action Item was taken by Dr Vince Orlando to talk to MIT Lincoln Labs about this issue.

5.0 Honeywell Proposed Requirement

Honeywell proposes that a requirement be added in DO-181D at §2.2.5.1.e and in ED-73C at §3.8.2.e which reads:

With P1 at MTL and S1 at MTL -3 dB, the transponder **shall** reply to ATCRBS interrogations 70% of the time or more.

This requirement may seem loose, but it accurately reflects currently fielded units over temperature plus some margin. At ambient conditions, most units perform quite well and reply 90% of the time. The problem essentially is that at high temp, legacy transponders do not continue to perform as well. Our analysis of the TCAS II Whisper-Shout steps, combined with the requirement above, shows that in a single round the probability of a single ATCRBS reply is still greater than 90%.

6.0 Collins Proposed Requirement

In an email discussion with Bob Saffell of Rockwell Collins on June 23, 2006, he alternately proposed the following requirements:

With P1 at MTL and S1 at MTL -6 dB, the transponder **shall** reply to ATCRBS interrogations at least 90 % of the time.

With P1 at MTL and S1 at MTL -3 dB, the transponder **shall** reply to ATCRBS interrogations at least 70 % of the time.

With P1 at MTL and S1 at MTL, the transponder **shall** reply to no more than 10% of ATCRBS interrogations. (Same as P1_P2 testing)

Honeywell is agreeable to the additional requirements proposed by Rockwell Collins.

7.0 Summary

In general, these requirements are not burdensome to existing equipment and will ensure that new designs test for compatibility with the TCAS system.